Understanding the Estimation and Uncertainty in the Costs of Ecosystem Restoration

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Session One

ABSTRACT

The estimation and accounting of direct financial costs of environmental restoration is challenging. In addition to the general lack of accurate cost accounting, recent experience has shown that the task of estimating costs for aquatic ecosystem restoration projects is subject to considerable uncertainty. This uncertainty often manifests itself in a significant difference between projected and actual costs of restoration projects. This presentation outline describes an analysis of available direct cost information for several aquatic habitat restoration projects and attempts to explain the uncertainty in the cost information that exists.

INTRODUCTION

This presentation outline briefly highlights results from an analysis of habitat restoration project costs and reviews findings of preliminary efforts to examine the factors that contribute to differences between projected costs and actual expenditures or the uncertainty factors in estimating costs. This work is based on research conducted by the Battelle Seattle Research Center as a part of two larger research and development programs of the Institute for Water Resources (IWR), U.S. Army Corps of Engineers (USACE):

1. The Evaluation of Environmental Investments Program which was designed to compile and compare management measures, engineering features, monitoring techniques, and detailed costs for a representative sample of "non" USACE environmental projects, and

2. The Risk Analysis of Water Resources Investments which was designed to develop approaches to issues of risk and uncertainty that arise in water resource planning, engineering, and design.

DIRECT COST ANALYSIS OF NON-USACE RESTORATION PROJECTS

Approach

A number of attempts have been made in the past to analyze restoration costs. Some of the primary studies we examined as part of our literature search are listed in Table 1. Notice the significant variation in total per acre costs (reported in nominal terms) across the studies. Given the former, we worked to overcome some of the past limitations of restoration costs estimation efforts and derive unit costs estimates for each component of a project from a representative sample of wetland and habitat restoration projects across the U.S. In particular, we were interested in examining the unit-cost estimates for each component of each restoration project, in hopes of getting truly specific information on the financial costs of habitat restoration.

In this first study we reviewed over 90 non-USACE habitat restoration projects across the U.S. The data for our final analysis was derived from 39 of the most comprehensive of these projects. Table 2 lists ranges of costs of components that appeared more than once in our sample for which total and per unit costs were reported.[1]

Findings

We found that because the elements associated with the restoration projects analyzed vary across projects, and costs are allocated in different ways across the entire sample, it was impossible to make any statistically significant comparisons of the costs of specific components across projects.

We did find, however through a qualitative review that there are several factors that affect restoration project costs (Table 3). Factors like economies of scale have a significant impact on costs, as does the type of restoration. Design, initial site quality and adjacent site quality also affect costs, as does the baseline condition from which the project begins. If the project involves something that has already been restored, the costs will differ from a site that has not been touched yet. Appropriate technology, simultaneous construction or use at the site, and project management will also impact costs.

ANALYSIS OF UNCERTAINTY IN RESTORATION COST ACCOUNTING

Approach

In our second project, we attempted to analyze the uncertainty in restoration cost accounting or the basic systematic factors

Table 1. Non-USACE restoration cost studies

STUDY	PROJECT TYPES	COST RANGES
King and Bohlen (1994)	Wetland mitigation	$5 to $1.5 million per acre
Guinon (1989)	Wetland restoration	$1,626 to $240,000 per acre
NOAA (1992)	Wetland creation	$485 to $70,000 per hectare
DOI (1991)	Wetland restoration, creation, mitigation	$2,000 to $50,000 per acre

1- This cost data is reported in 1995 dollars.

Table 2. Comparable construction costs

ACTIVITY TYPE	COST RANGES
Gravel removal	$3.27 to $3,239 per ton
Rip rap installation	$5.00 to $19.00 per ton
Culvert installation	$150 (for 48" diameter culvert) to $1,103.85 per ft.
Channel cleaning	$4.00 to $8.00 per m^3.
Erosion control	$1.40 to $4.00 per ft^2.
Dike removal	$1.92 to $2.67 per linear ft.
Dike/dam/levees construction	$5.00 to $20.00 per linear ft.

Table 3. Primary factors affecting restoration costs

- Economies of scale
- Type of restoration
- Restoration design
- Restoration site quality
- Adjacent site quality
- Appropriate technology
- Simultaneous construction/multiple use
- Project management

that contribute to the difference between estimated and actual project costs. We wanted to determine whether cost differences was driven by errors in estimating the costs of labor and/or materials, or whether factors such as design difficulties and unanticipated site conditions were most directly responsible. Ultimately we hoped to identify procedural improvements for estimating and tracking project costs.

Data on estimated costs and actual expenditures were gathered for this study through several databases and paper files. In addition, a telephone survey targeted at project managers was developed and implemented. At their request, USACE projects — including Section 1135, their upper Mississippi program, and the Breaux Bill (Coastal Wetlands Planning, Protection, and Restoration Act) program — were the focus of our analysis. Data gathered from previous IWR studies were also used.

In the end, information on 47 projects was collected nationwide. A significant number were Midwest projects, as that is where many restoration efforts have been carried out. Some of the projects were from the West Coast and some were South Central Louisiana Corps projects. Data were categorized in terms of project types, separating the projects into *river/lake*, *wetlands*, and *other general habitat restoration* projects. Several of these included a salmon habitat restoration component. Data were also categorized in terms of management measures and whether the project involved a water control structure, re-vegetation, or what we

called an "integrated ecosystem" restoration (e.g., removing a culvert and doing some replanting — anything that included more than one component).

The area of habitat restoration is a relatively new and evolving area of emphasis. Therefore, we focused on relatively recent projects that reflect the practical knowledge gained from past restoration efforts. Most projects included in the final sample were completed some time within the last ten years.

Our fundamental approach was to compare estimated costs to actual expenditures. We started by collecting our cost information at a very detailed level, looking again at materials, labor, monitoring, and maintenance. However we ultimately focused on three broad categories: planning and design, construction and construction management, and maintenance and monitoring costs. We had to aggregate back up again because of inconsistencies in the reporting and because we did not find the refined level of information we were seeking. Our final analysis focused on those projects with a "significant" difference between estimated and actual cost. "Significant" we arbitrarily defined as cost overruns or underruns of at least $100,000 or 20% of the original estimate.

Findings

Cost Discrepancies

The projects analyzed reflected a wide range of costs, as expected from past experience. We discovered that the wetland projects were less costly than most of the river and lake projects. We also discovered many of the least costly projects focused on re-vegetation or small drainage kinds of projects. The larger, integrated multi-dimensional projects were the most costly.

Approximately 30% of the sample involved some kind of cost overrun. A comparable percentage of projects were significantly under budget. Overruns varied from less than $100,000 to more than $2 million. The majority of cost overruns were related to construction rather than additional planning. On average, 95% of added cost went into construction. (Note, however, that this doesn't eliminate planning and design as important to cost uncertainty.) We discovered in talking to project managers and planners that the central problem lies in lack of thorough planning. Managers often reported they felt pushed to move in and implement before they were comfortable with their site preparation, site analysis, or planning activity. This approach has led to project change orders, delays, etc.

Further, it was learned that cost discrepancies decrease with cumulative experience, as only four of the projects completed since 1997 had major overruns. Learning therefore appears to be significantly related to uncertainty.

Cost overruns were more common in river and lake projects than in wetland creation and restoration projects (9 of 14). Some further analysis into the data and interview information indicated two reasons for this. First, the river/lake category included a number of larger projects where a general lack of experience could have played a part. Second, a number of the contractors were apparently less familiar with some of these types of larger river/lake projects. That unfamiliarity, combined with lack of cumulative experience, may have led to greater cost overruns.

Critical Factors in Restoration Cost Uncertainty

In the project-manager survey mentioned earlier, we asked a number of specific questions. Interestingly, across all the different types of projects, the same kinds of responses came up again and again. In talking to these individuals the uncertainty (discrepancies) that we had expected was not necessarily

linked to cost reporting or cost accounting, but to a wider variety of factors as outlined below:

Incomplete site surveys: Unexpectedly difficult working conditions can always lead to cost overrun. Planners understand that a more detailed survey of a site may be important, but it clearly costs more money. There exists a significant tradeoff: How much time do you spend on sites before you design your project and move ahead toward implementation?

Insufficiently detailed planning: Local partners often feel pushed to "turn over the soil" before they feel prepared to move into implementation.

Project experience: Over time, experience can reduce some cost uncertainty.

Project scheduling or habitat protection: Often there is a need to suspend work to protect habitat areas during critical periods, whether it is spawning, mating, etc. Such suspensions can impact the cost of a project. This is a particularly interesting issue in salmon habitat restoration.

Difficulties with land acquisition: There can often be conflict with a property owner when needing to purchase and/or use a particular property. There can also be disputes over compensation. All of this takes time and adds to the costs of the program.